SILVICAL CHARACTERISTICS of BLACK LOCUST

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This is the sixteenth of a series of 17 papers dealing with the silvical characteristics of forest trees important in the Central States region. The following species are included in this series. (Those marked with an asterisk have already been published.)

*Ohio buckeye
*Yellow buckeye
*Northern red oak
*Black oak
*Chinkapin oak
*Pin oak
*White oak
*Swamp white oak
*Bur oak
*Butternut
*Black walnut
*Shellbark hickory
*Sycamore
*Honeylocust
Hackberry
*Black locust
*Eastern redcedar

Papers covering additional important American species will be issued by other Forest Experiment Stations of the U. S. Forest Service.

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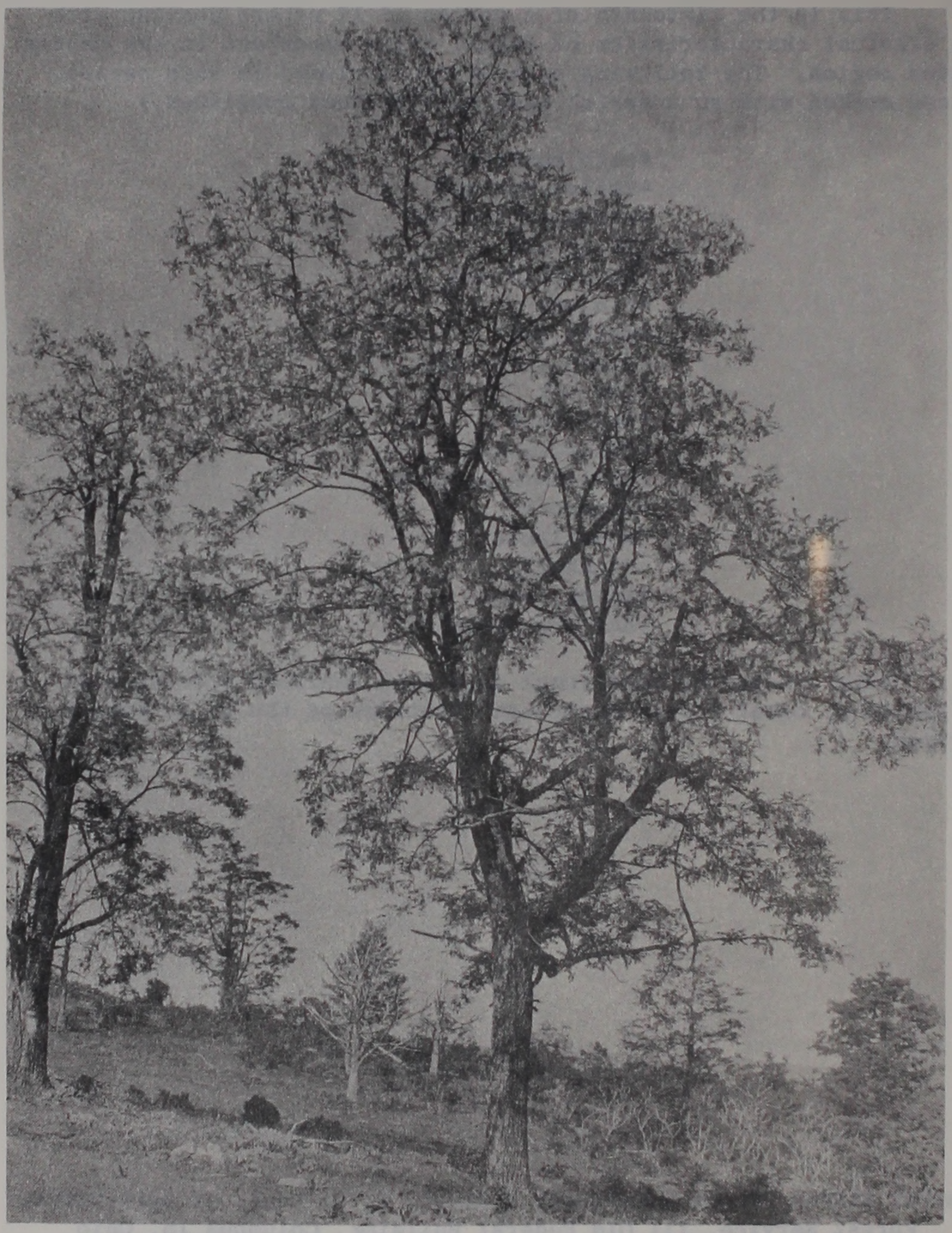

Silvical Characteristics of Black Locust

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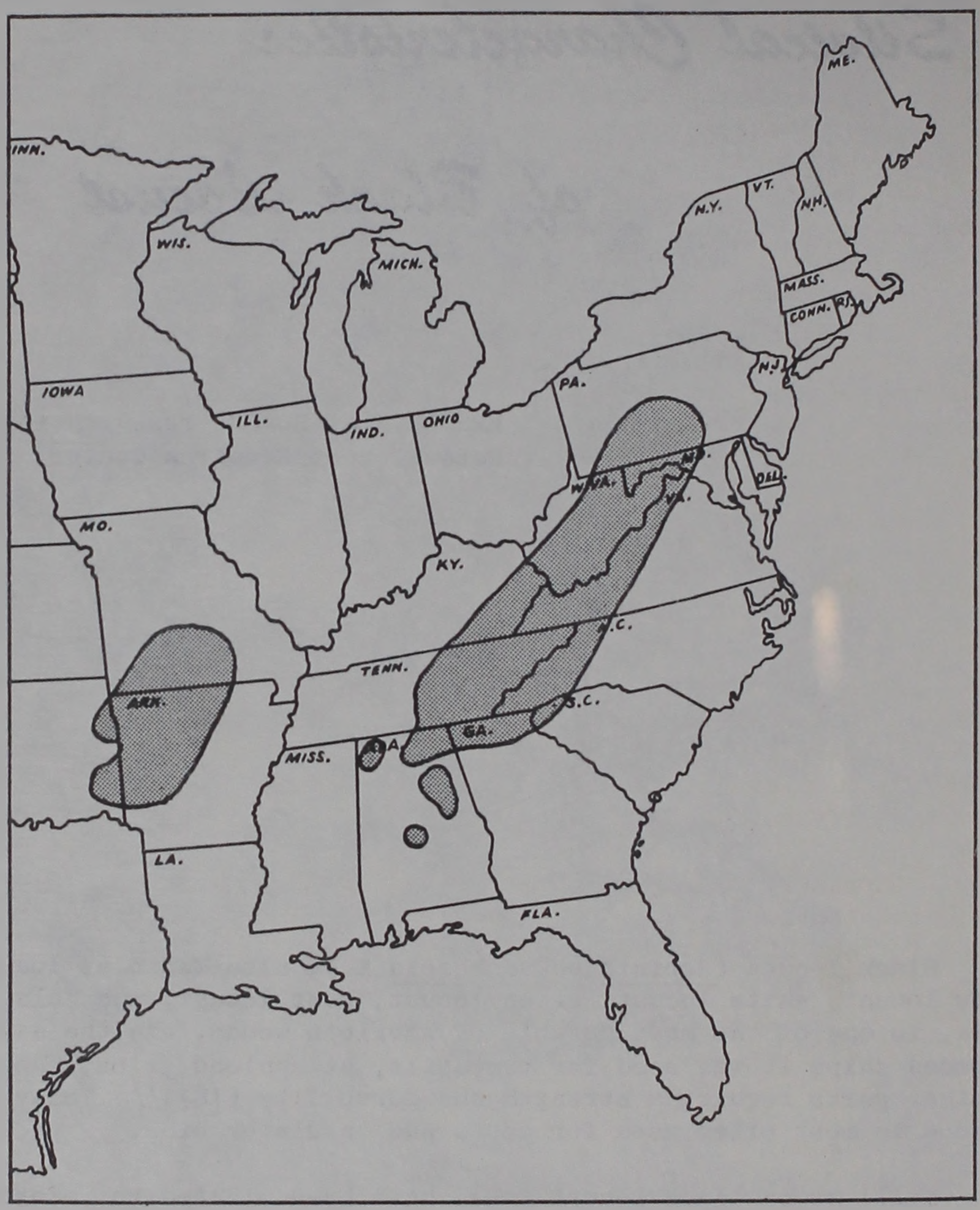
Black locust (Robinia pseudoacacia L.), also known as locust, yellow locust, white locust, green locust, post locust, and false acacia, is one of the most durable of American woods. In the days of wooden ships it was used for treenails, stanchions, ribs, knees, and other parts requiring strength and durability (18).[1/] Today the wood is most often used for posts and insulator pins.

Millions of black locust trees have been planted to reforest the spoil banks of strip mines, to control erosion in gullies and fields, and for fence posts. Locust has been widely planted in Europe, especially in eastern France and western Germany. In the United States successful plantations have been established as far west as Oregon, Washington, Idaho, and Utah. East of the Rocky Mountains and in southern Canada black locust has become so thoroughly naturalized that its original range is not accurately known (30).

1/ Numbers in parentheses refer to Literature Cited, p. 11.

DISTRIBUTION



SITE

Climate

The original range of black locust was in regions of humid climate as defined by Thornthwaite (44). Throughout this range the average annual precipitation varies from 40 to 60 inches per year: Summer precipitation (June to August) averages 12 to 16 inches and annual snowfall ranges from 5 to 40 inches (45). The species has since been planted and apparently has become naturalized in drier areas.

The average July temperature over the botanical range varies from 70° to 80° F. with an average annual extreme high of 95° to 100° F. Average January temperatures range from 35° to 45° F. with an average annual extreme low of 10° to minus 10° F. In West Virginia, where black locust develops best, the highest recorded temperature was 110° F. and the lowest was minus 30° F. (45).

Average duration of the annual frost-free period is 140 to 220 days (45).

Soils

Black locust will live on a variety of soils but grows best on deep, well-drained, fertile loams. Soils derived from limestone are especially favorable (18, 24, 33) even if these are acid (3). Generally development is poor on very dry or very wet sites and on heavy or very acid soils (18, 33, 38).

Auten (1, 3) found the growth of black locust in Central States plantations to be closely correlated with properties of the subsoil that influence drainage and aeration: Plasticity, compactness, and structure. The amount of mineral nutrients present and differences in soil reaction between pH 4.6 to pH 8.2 did not seem to affect growth. On the poorly drained sites that had compact plastic subsoil, growth was slow, especially if the subsoil was less than 14 inches below the surface. Excessively dry soils indicated by coarse, sandy moraines or by a soil depth of less than 24 inches to bedrock, were also poor sites. Growth was best on soils without a pronounced subsoil development. But yellow, brown, or reddish-brown subsoils without pronounced mottling were better than gray, bluish-gray, or yellow subsoils mottled any color. Silt loams, sandy loams, and the lighter textured soils were superior to clay, silty clay loams, and the heavier soils as planting sites.

Physiography

Within its original range the species occurs naturally in the Appalachian Mountains below an elevation of 3,500 feet (41). Singly or in small groups, it frequents the slopes, coves, and borders of the forest (18). In West Virginia it is more common on south and west slopes than on north and east slopes or in coves.

Associated Species

Black locust is designated as a type name by the Society of American Foresters when the species occurs pure or is predominant in the stand. The type may contain many species of hardwoods and hard pine in mixture. It is a temporary type, spotty in occurrence, but widely distributed throughout the Central Forest where it has been extensively planted on old fields (42, 49). It frequently occurs on burned-over land (18, 47), and has reproduced naturally as an old-field type in parts of West Virginia, western Maryland, and eastern Kentucky.

Black locust is also listed as a minor component of five other types: Scarlet oak, bear oak, eastern redcedar - hardwood, white oak red oak - hickory, and yellow poplar (42, 49).

Within its original range, black locust usually appears in mixture with black oak, red oak, chestnut oak, pignut hickory, yellow-poplar, and maple in coves and on slopes. Alsong streams it is associated with ash, maple, black walnut and others (18). Along the west border of the southern Appalachians it is associated with various hard pines: Shortleaf, table mountain, pitch, and Virginia pine (7).

LIFE HISTORY

Seeding Habits

Flowering and Fruiting

The perfect flowers are white, fragrant, and filled with a nectar very attractive to bees and other insects (11). The flowers appear in May and early June about a month after the leaves appear and originate from the axils of the leaves of the current year (28, 41, 48).

The fruit is a pod which ripens in September or October. Each pod contains 4 to 8 seeds whose hard outer coats are usually impervious to water (41, 48).

Seed Production and Dissemination

Black locust is a good seed producer (33, 49). Heavy seed crops occur at 1- or 2-year intervals, and light crops occur in the intervening years. Best seed crops occur when the trees are between 15 and 40 years of age, but some trees will bear at 6 years and some as late as 60 years (48). An exception is the shipmast variety (Robinia pseudoacacia var. rectissima) which on Long Island produces few if any seeds (40). In the Central States, though, shipmast bears seeds prolifically (48).

Seed pods open while on the tree during the winter and early spring. One hundred pounds of pods will produce 15 to 33 pounds of clean seed (1/4 to 1/2 bushel). There are 16,000 to 35,000 seed per pound which, in commercial lots, are 90 to 99 percent sound (48).

Vegetative Reproduction

The sprouting and root-suckering ability of black locust is high (24, 33, 49), and natural reproduction is largely by this means (48). The new suckers apparently form from dormant invisible rudiments that occur naturally where branch roots emerge from the older roots (43).

The tree is established readily from root cuttings or by transplanting natural sprouts. The latter method has been extensively used in propagating shipmast locust on Long Island (43).

Locust can also be propagated by hardwood cuttings (cuttings of mature wood), by budding and other types of grafting, and by division of the crown (43). Stem cuttings made late in the summer (softwood cuttings) have been tried also, but only 4 percent of the cuttings were successful in establishing roots (43).

Seedling Development

Establishment

Despite the frequent heavy seed crops, seedling reproduction is rare because few of the seeds germinate. This dormancy is probably all due to the impermeable seed coat and may be overcome in the nursery by scarification, treatment with sulfuric acid, or soaking in hot water (48). Germination is best in a fresh, moist seedbed of mineral soil (48).

Early Growth

Survival and early growth in plantations are greatly influenced by the planting site. Black locust was originally thought to tolerate a wide range of site conditions. However, later studies show that on poor sites the tree will not survive or else will not devleop in competition with other trees, vines, or grasses, or on poorly drained, heavy-textured soils (6, 10, 21, 34). Many plantations established for erosion control, particularly in the South, have failed for these reasons.

In several instances fertilizer supplements, especially phosphates, applied at the time of planting, have resulted in increased height, diameter, and root growth of seedling black locust (16, 19, 31).

Early height growth of seedlings is rapid. For the first ten years it averages 1 1/2 feet per year for areas with a site index of 30 to 40. On good sites (site index 90 or more) annual height growth averages 4 feet or more (26).

Average annual diameter growth of seedlings ranges from 1/6 inch for site class 30 to 1/2 inch for site class 90 or more (26). Natural sprout stands grow even faster (26, 27).

Sapling Stage to Maturity

Growth Rates and Size Attained

Black locust grows fast on areas where the site index is 75 or more (3). Measurements of sample plots in typical plantations in the Central States showed the following (26, 27):

AVERAGE D.B.H. (Inches)

Age (Years)	Site index at age 50 years		
	30	60	90
10	1.6	2.8	4.4
25	4.1	6.0	8.4
40	-	-	10.8

AVERAGE HEIGHT DOMINANTS (Feet)

10	12	27	42
25	25	46	68
40	30	58	84

Kellogg notes that some natural sprout stands have exceeded these heights by 10 to 20 feet (26, 27).

Average yield for 22 plantations 27 years of age in the Central States was 1,800 cubic feet per acre. This was equivalent to 1,100 posts or 4,100 board-feet per acre (International 1/8" rule) (22).

The species has an early commerical maturity and should be cut by the time it reaches 20 to 30 years of age, or possibly 40 years on the most favorable sites (33, 47). Ordinarily it requires 15 to 20 years to produce post-size trees, and 30 years to produce 8-inch bolts on the best sites (26).

In its native habitat black locust is a small to medium-sized tree which attains a height of 40 to 80 feet and a diameter of 1 to 3 feet (24, 41). When forest gorwn it produces a clear, straight bole, but in the open it tends to fork and become crooked and limby. Some of this tendency may be inherited (25).

Reaction to Competition

Black locust is classified as very intolerant (the least tolerant class) by Baker (4), and is not found in dense woods except as a dominant tree (24). Where it has room to grow, its rapid growth rate enables it to compete successfully with other species. Erosion-control plantings on uncultivated, grassy areas adjacent to gullies have often failed because of competing grasses (12, 34).

Unpublished data from the Southern Forest Experiment Station show that in the first 5 years after planting black locust on four sites on loessal soils, survival of released trees was more than double that of unreleased trees. Height growth of released trees ranged from four to six times that of unreleased trees.

ENEMIES AND HAZARDS

Black locust is normally a very shallow-rooted species that does not produce a taproot (23). It is sensitive to soil conditions that produce excessive aeration and drainage, or that impede aeration and drainage. Thus it is adversely affected by water-logged soils or heavy grazing. Even if the tree survives under these conditions, root nodulation is poor and its nitrogen-fixing properties are reduced (8).

Insects

Of several insects attacking the tree, the locust borer (Megacyllene robiniae) causes the most severe economic damage. Its larval tunnels subject the tree to wind breakage and render its wood unfit for commercial use (15). Slowly growing trees are most susceptible. Rapidly growing trees more than 10 years old can usually overcome attack (23). Careful selection of planting sites and stimulation of growth rate are recommended methods for minimizing borer damage (15). Maintaining heavy shade by means of dense stands or mixed plantings also reduces borer damage, especially on the better sites (15). This may be due to a lower rate of oviposition because of lower temperatures in shaded stands (23).

The locust leaf miner (Chalepus dorsalis) attacks the tree by mining the leaves in late summer and early fall. Trees suffering heavy attack have a conspicuous "burned" appearance and suffer a loss in seasonal growth (15, 33).

The locust twig borer (Ecdytolopha insiticiana) is also important. It attacks only new growth, working inside the twigs and forming an elongate gall 1 to 3 inches long (15). This retards growth and distorts the limbs.

Diseases

The most damaging disease of black locust is a heart rot, (Fomes rimosus). It often follows borer attack and ruins potential products, especially in older trees (5, 32).

In nursery beds the species is highly susceptible to chlorosis and damping off (5).

Weather

Prolonged drought, especially on normally moist soils, causes a reduction in growth rate and vigor which in turn create conditions favorable for infestations of the locust borer (23). Spring drought in particular results in a great increase in borer attack (14, 15). During periods of extreme drought the girdling effect of the borer is greatly increased because the larvae then feed only on phloem instead of feeding on both phloem and wood as they normally do (23).

Black locust is classed as moderately frost hardy in the southern and central plains (46). However glaze damage, frost damage, and frost heaving in plantations have occurred in the colder parts of its extended range (5, 13, 17, 35, 36).

Fire

Black locust is very susceptible to fire damage, especially when young, because of its thin bark and shallow root system (21, 33).

RACES AND HYBRIDS

Many horticultural forms have been distinguished (30, 48). A clone of the species, shipmast locust, is found along parts of the eastern seaboard, in Massachusetts, New York, and New Jersey (30). It differs from the parent species in its more erect stem, narrower crown, thicker bark, more durable wood, higher resistance to borer attack, and little if any seed production (40). Tests have shown that it is not superior to common black locust in growth rate, form, or resistance to borer damage when grown in the Central States (37, 48).

Other geographic strains have been reported but none are supported by experimental evidence. It is believed that many of these represent only differences in response to various site factors (48).

No hybrids have been recognized.

SPECIAL FEATURES

Black locust is a legume. Nitrogen-fixing bacteria, associated with nodules on the roots, increase the nitrogen content of the soil in which the tree grows. This action improves the soil for other plants. Thus black locust has proved to be an excellent nurse crop for underplated central hardwoods. The hardwood species tested showed significantly greater height growth when planted under locust cover (8, 9, 20). In addition Auten (2) found that locust litter contains much calcium and nitrogen. This litter decomposes rapidly and releases soluble nitrates that are readily available to other plants.

Black locust is one of the best hardwood species for controlling erosion on sites to which it is adapted (29), and the tree has has been widely planted for this purpose. However, failure of many erosion control plantings shows that the species should not be expected to develop effectively under severe competition, on sites with little surface soil, or on sites where drainage and aeration are either deficient or excessive (6, 21, 34).

The heartwood of black locust is among the most durable of woods. In addition it is hard, strong, and shock resistant. These characteristics make it especially suitable for posts, small poles, stakes, ties, mine timbers, insulator pins, and tree nails (18, 47).

The inner bark of black locust contains a phytotoxin (named robin) capable of killing livestock if eaten in large quantities (39).

TREE SPECIES MENTIONED

Ash	-	*Fraxinus* L.
Pignut hickory	-	*Carya glabra* (Mill.) Sweet
Black locust	-	*Robinia pseudoacacia* L.
Shipmast locust	-	*R. pseudoacacia* var. *rectissima* Raber
Maple	-	*Acer* L.
Bear oak	-	*Quercus ilicifolia* Wangenh.
Chestnut oak	-	*Q. prinus* L.
Northern red oak	-	*Q. rubra* L.
Scarlet oak	-	*Q. coccinea* Muenchh.
White oak	-	*Q. alba* L.
Pitch pine	-	*Pinus rigida* Mill.
Shortleaf pine	-	*P. echinata* Mill.
Table-mountain pine	-	*P. pungens* Lamb.
Virginia pine	-	*P. virginiana* Mill.
Eastern redcedar	-	*Juniperus virginiana* L.
Black walnut	-	*Juglans nigra* L.
Yellow-poplar	-	*Liriodendron tulipifera* L.

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